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D. Remarks

1. Rejection of Claims 1-3, 5, 7 and 9-10 Under 35 U.S.C. §103(a), based on U.S. Patent No. 6,100,202 (*Lin et al.*) in view of U.S. Patent No. 6,541,394 (*Chen et al.*).

The invention of claim 1 is directed to a method that includes varying a dopant supply rate for a doped insulating layer according to a variation in temperature of a substrate on which the doped insulating layer is formed. Varying the dopant supply rate includes increasing the dopant supply rate as the substrate temperature increases.

As is well known, to establish a prima facie case of obviousness, a rejection must meet three basic criteria. First, there must be some suggestion or motivation to modify a reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference(s) must teach or suggest all claim limitations.

a. The Combination of References Does Not Show All the Limitations of Claim 1.

The cited references do not show or suggest the limitations of

1) varying a dopant supply rate for a doped insulating layer, wherein
2) varying the dopant supply rate includes increasing the dopant supply rate.

The reference *Chen et al.* provides no teachings regarding doped insulating layers, thus this reference cannot show or suggest the above claim limitations.

The remaining reference relied upon by the rejection, *Lin et al.*, does not show or suggest the above limitations, either.

Applicants have previously described the various examples set forth in *Lin et al.*, and illustrated how such examples do not show the above claim limitations. In particular, Applicant noted that the examples shown in *Lin et al.* show either (1) no variation in a dopant supply rate or (2) a decreasing dopant supply rate.

In response to Applicants arguments on this point, the final rejection responds as follows:

> Applicant argued that Lin et al. never shows "increasing the dopant supply rate". However, Lin et al. teaches increasing the dopant supply rate because the dopant

> supply rate is increased from zero... to the flow of the dopant source material during the deposition of the doped silicate glass dielectric...[1]

The above argument overlooks Applicants claim language. Applicants' claim 1 recites:

> "varying a dopant supply rate for a doped insulating layer".

If one is forming an insulating layer with a dopant supply rate of zero, as argued by the rejection, one cannot be varying a dopant supply for a doped insulating layer, as one is forming an undoped insulating layer.

Applicants will again, review the examples of *Lin et al.* in light of this fact.

The general method of *Lin et al.* describes a method that includes (1) a pre-deposition stabilization process step and (2) a doped silicate glass dielectric formation step. The pre-deposition stabilization is intentionally undoped and thus cannot show or suggest Applicants' claim 1limitations:

> [A] pre-deposition stabilization process step where the substrate is stabilized with respect to a first flow of a silicon source material *absent a dopant source material.*[2]

As emphasized above, Applicants claim 1 limitations are directed to varying a dopant supply rate for a doped insulating layer. Accordingly, this pre-deposition stabilization process cannot show or suggest such claim limitations as it intentionally forms an undoped insulating layer.

The general method of *Lin et al.* proceeds to describe the formation of a doped silicate glass. However, as emphasized by the Applicants in the previous responses, the dopant supply rate is never varied, let alone increased:

> Subsequent to the pre-deposition stabilization process step, the doped silicate glass dielectric layer is formed employing a second flow of the silicon source

[1] See the Final Office Action, dated 02/05/2004, Page 6, last full paragraph.
[2] *Lin et al.*, Col. 5, Lines 61-62, emphasis added.

> material, a flow of an oxidant source material and the flow of the dopant source material.[3]

Thus, with respect to a doped layer, the above excerpt only describes one unvarying flow rate for the dopant source material. Accordingly, this first example does not show any variation in dopant supply rate.

The next example of *Lin et al.* is no more suggestive of Applicants claim 1 limitations than the above first example.

The second example describes the formation of a doped pre-metal dielectric (PMD) layer 44 formed over an undoped PMD layer 40. However, in forming PMD layer 44, a dopant supply is never varied.[4] Particular ranges are given for the flow of dopant source materials[5], but variation or an increasing supply rate are not shown or suggested by this example.

As in the case of the first example of *Lin et al.*, Applicants do not believe that the two deposition steps of forming the undoped PMD layer 40 and subsequently forming the doped PMD layer 44 can show or suggest the limitations of claim 1. That is, steps for forming the undoped PMD layer cannot be construed as showing a dopant supply rate of a doped insulating layer.

As noted in Applicant's previous response to office action, the last example of *Lin et al.* does not show or suggest the above noted limitations of Applicant's claim 1, as the reference explicitly teaches decreasing a dopant flow rate.

> The second deposition step employed materials and flows otherwise equivalent to those employed within the first deposition step, with the exception that the triethyl phosphite flow was *reduced* to about 34... sccm...[6]

Applicants' believe all of the above demonstrates that the reference *Lin et al.* does not show or suggest "increasing the dopant supply rate" as recited in claim 1.

For all of the above reasons, Applicants believe that the cited combination of references

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[3] *Lin et al.*, Col. 5, Lines 63-67.
[4] *Lin et al.*, Col. 9, Lines 23-27.
[5] See *Lin et al.*, Col. 10, Lines 11-13.
[6] *Lin et al.*, Col. 15, Lines 22-26, emphasis added.

does not show all limitations of a claim 1, a thus a prima facie case of obvious cannot have been established.

b. <u>The Combination of References Does Not Provide Motivation for the Proposed Combination.</u>

In addition or alternatively, Applicants believe that the requisite motivation necessary to combine *Lin et al.* in view of *Chen et al.*, as proposed by the rejection, is lacking. The rejection proposes modifying the <u>doped</u> insulating layer teachings of *Lin et al.* in view of *Chen et al.* as follows:

> [I]t would have been obvious... to modify Lin et al. reference by increasing the temperature as taught by Chen et al. in order to reduce stress and to increase reliability...[7]

Applicants' previous response set forth a clear showing that *Chen et al.* taught away from combination with *Lin et al.* The rejection has responded to Applicants' showing as follows:

> In response to applicant's arguments... Chen et al. is cited as evidence to show that increasing the temperature during the formation of the insulating layer is well known in the art... In addition, disclosed examples and preferred embodiments doe not constitute teaching away from a broader disclosure or nonpreferred embodiments.

Applicants' previous showing, with full citations, did not refer only to specific examples or embodiments, and presents the broad teachings of the reference. Further, ignoring Applicants' showing regarding the full teachings of the reference is improper:

> [P]rior art references... must be read as a whole and consideration must be given where the references diverge and teach away from the claimed invention...[8]

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[7] See the Final Office Action, dated 02/05/2004, Page 3, Lines 11-14.

[8] <u>Akzo N.V. v. United States Intl' Trade Comm'n</u>, 1 USPQ 2d 1241, 1246 (Fed. Cir. 1986).

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As noted above, the base reference *Lin et al.* describes the deposition of a doped pre-metal dielectric (PMD) layer. The doping of such a layer includes phosphorous and/or boron.[9] The broad disclosure of *Chen et al.* (not only the disclosed examples) indicates dopants in such a film are undesirable:

> The introduction of nitrogen atoms into the gate dielectric may *suppress diffusion of boron atoms* from heavily doped p+ polycrystalline silicon gate electrodes...[10]

> Silicon dioxide is not a good *diffusion barrier for gate electrode dopants*, such as boron.[11]

> The first oxide portion 31 may further comprise an uppermost nitride portion, for example, not shown. The nitride portion serves to *block dopant penetration in to the oxide layer 30* as will be readily understood by those skilled in the art.[12]

These excerpts are not examples or embodiments, but are taken from the BACKGROUND OF THE INVENTION of *Chen et al.* A full reading of this material shows that the broad teachings of the reference are that dopants are undesirable and need to be blocked by way of a barrier. Thus, the various embodiments are all directed to undoped oxide layers.

The above is believed to clearly show that the broad teachings of the reference *Chen et al.* are directed to blocking dopants from entering a gate oxide layer, thus teaches away from forming a doped oxide layer. Accordingly, the motivation for combining *Lin et al.* in view of *Chen et al.*, necessary to establish a prima facie case of obviousness, is believed to be lacking.

c. Applicants' Reply is Fully Responsive.

Finally, with regard to claim 1, the rejection has raised the issue that Applicants' arguments do not fully address the rejection:

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[9] See *Lin et al.*, Col. 9, Lines 31-39.
[10] *Chen et al.*, Col. 1, Lines 50-53, emphasis added.
[11] *Chen et al.*, Col. 2, Lines 12-13, emphasis added.
[12] *Chen et al.*, Col. 2, Lines 50-53, emphasis added.

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> In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking the references individually where the rejections are based on combinations of references.[13]

Applicants' believe the above and previous showings have not attacked individual references, but have attacked the prima face case presented by the rejections. Applicants will thus clarify their understanding of the arguments.

First, the rejection of claim 1 relies on *Lin et al.* to show the limitations of varying a dopant supply rate for a doped insulating layer:

> Lin et al. teaches varying a dopant supply rate for a doped insulating layer...[14]

Thus, it is the rejection that argues the above particular limitation is taught by *Lin et al.* Applicants' argument in Section D.1.a. above is provided to show that such a limitation is not shown in the reference. Accordingly, Applicants are not arguing against a single reference, but pointing out perceived shortcomings in the prima facie case presented.

Second, the rejection of claim 1 <u>admits</u> that the base reference *Lin et al.* provides no teachings regarding increasing a substrate temperature:

> Lin et al. does not specifically show increasing the substrate temperature.[15]

To show such a limitation, the rejection relies on the secondary reference *Chen et al.* Further, motivation for the proposed combination is taken from *Chen et al.*

> [I]t would have been obvious... to modify Lin et al. reference by increasing the temperature as taught by Chen et al. in order to reduce stress and to increase reliability (Chen et al., col. 3, lines 31-33)[16]

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[13] See the Final Office Action, dated 02/05/2004, Page 7, Lines 7-10.
[14] Final Office Action, dated 02/05/2004, Page 2, third line of section 3.
[15] Final Office Action, dated 02/05/2004, Page 3, Line 8.
[16] See the Final Office Action, dated 02/05/2004, Page 3, Lines 11-14.

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Thus, it is the rejection that argues motivation for the prima facie case is found in *Chen et al.* Applicants' argument in Section D.1.b. above is provided to show that the reference does not provide such motivation. Accordingly, in this case too, Applicants are not arguing against a single reference, but are pointing out perceived shortcomings in the prima facie case presented.

In summary, Applicants' arguments are not attacks on single references but responsive arguments to the very particular grounds for rejection raised by the Examiner.

d. Applicants' Arguments Regarding Claim 3 Remain Unrebutted.

Applicants dependent claim 3 includes additional limitations not shown or suggested by the cited reference. Claim 3 recites that different dopant supply rates are provided for different time periods. Further, the different time periods include periods of the same length.

The reference *Chen et al.* provides no teachings regarding doped insulating layers, thus this reference cannot show or suggest the above claim limitations. Accordingly, Applicants will address the teachings of *Lin et al.* Accordingly, Applicants are not attacking *Lin et al.* individually, but are showing that the limitations of claim 3 are not shown in the reference (attaching any prima facie case).

The rejection has not addressed Applicants' previous showing regarding this claim. Accordingly the argument will be repeated.

As understood from the above arguments for claim 1, there is only one example in *Lin et al.* that shows different flow rates for a phosphorous dopant source. The example teaches first and second deposition steps. However, such deposition steps are for time periods of different lengths:

> The first deposition step employed... for a time period of about *2 seconds*. The second deposition step employed... for a time period of about *180 seconds*...[17]

Applicants' believe the above disparity in time period lengths (2 seconds versus 180 seconds) clearly teaches away from the "periods of same length" limitation set forth in claim 3.

[17] *Lin et al.*, Col. 15, Lines 12-28, emphasis added.

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For this additional reason, a prima facie case is not believed to have been established for claim 3.

2. Rejection of Claim 4 Under 35 U.S.C. §103(a), based on *Lin et al.* in view of *Chen et al.* and further in view of U.S. Patent No. 6,355,581 (*Vassiliev et al.*).

To the extent that this ground for rejection relies on the combination of *Lin et al.* in view of *Chen et al.*, the comments set forth above for claim 1 are incorporated by reference herein. Namely, the combination does not show or suggest all limitations of claim 1 and/or motivation for combining *Lin et al.* in view of *Chen et al.* is believed to be lacking.

3. Rejection of Claim 8 Under 35 U.S.C. §103(a), based on *Lin et al.* in view of *Chen et al.* and further in view of U.S. Patent No. 4,376,672 (*Wang et al.*).

To the extent that this ground for rejection relies on the combination of *Lin et al.* in view of *Chen et al.*, the comments set forth above for claim 1 are incorporated by reference herein. Namely, the combination does not show or suggest all limitations of claim 1 and/or motivation for combining *Lin et al.* in view of *Chen et al.* is believed to be lacking.

4. Rejection of Claims 11, 13-16 and 18-19 Under 35 U.S.C. §103(a), based on *Lin et al.* in view of *Barnes et al.* (U.S. Patent No. 6,251,546), further in view of *Wang et al.* (U.S. Patent No. 4,376,672).

The invention of amended claim 11 is directed to a method that includes compensating for a temperature dependent gradient in a doped insulating film. The doped insulating film comprises silicon oxide with a phosphorous concentration greater than about 7% by weight. Such a compensating step includes varying a dopant supply rate as the doped insulating film is formed. Further, the dopant supply rate is varied for an initial thickness of the doped insulating film to compensate for variations in a substrate temperature.

a. The Combination of References Does Not Show All the Limitations of Claim 11.

As emphasized above, Applicants' claim 11 invention includes compensating for a temperature dependent gradient in a doped insulating film comprising silicon dioxide. Such a limitation is not shown or suggested by the cited combination of references.

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It is admitted that *Lin et al.* does not show compensating for a temperature dependent gradient.[18] However, such a limitation is not shown in the remaining references, either.

While Applicants believe that the term compensate is understood, one definition is set forth below to emphasize the difference between the claim language and the cited references.

> Main Entry: **com pen sate**
>
> **1** : to be equivalent to : <u>COUNTERBALANCE</u>
>
> **2** : to make an appropriate and usually counterbalancing payment to
>
> **3 a** : to provide with means of counteracting variation **b** : to neutralize the effect of (variations)[19]

This understanding of the word "Compensation" is also well supported in the Specification.

> The embodiments set forth approaches to forming an insulating material having essentially uniform doping on a substrate, while the temperature of the substrate varies. In one particular embodiment, flow rates of source gases can be varied to ***compensate*** for the effect of substrate temperature on dopant concentration.[20]

> According to the present invention, as a substrate temperature varies, a dopant supply rate can vary in a ***compensating*** fashion (e.g., increase, decrease or some variation thereof). As but one example, if an increase in temperature can result in lower concentration levels, a dopant source material supply rate can increase in time period Td.[21]

> To ***compensate*** for such variation, a temperature varying period may be divided into time periods (in the example, four periods of two seconds each). In each time period, a ratio may be adjusted to compensate for temperature effects on doping

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[18] See the Final Office Action, dated 02/05/2004, Page 5, Lines 10-15.
[19] <u>Merriam-Webster On-Line Dictionary</u>, Internet: http://www.m-w.com.
[20] Applicants' Specification, Page 6, Lines 13-16.
[21] Applicants' Specification, Page 6, Line 22 to Page 7, Line 1-2.

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concentration.[22]

The prima facie case presented by the rejection appears to argue that Applicants compensation limitation of claim 11 is shown or suggested by *Barnes et al.*:

> Lin et al. does not specifically show compensating for a temperature dopant gradient… However, Barnes et al. teaches that the dopant concentration is dependent from the reaction temperature (col. 6, lines 40-55, col. 7, lines 14-18). Barnes et al. shows using a feed back-based temperature control system and process gas control system that adjust the flow rates of the gas as necessary (col. 3, lines 15-23, 55-67).[23]

Applicants note that the above rationale never indicates how/why *Barnes et al.* shows "compensation of a temperature dependent dopant gradient by varying a dopant supply rate". The above language only appears to argue that the system ***might*** be capable of such an operation.

In addition, and importantly, *Barnes et al.* uses temperature feedback to control the temperature of a wafer.[24] *Barnes et al.* <u>does not</u> show or suggest using temperature feedback to control a dopant flow rate.[25]

Barnes et al. teaches <u>relationships</u> between temperature and insulating layer properties. More particularly, the reference teaches that as deposition temperature increases, a resulting dielectric constant decreases. In addition, as an impurity level (fluorine and/or carbon concentration) increases, a dielectric constant of the insulating layer decreases.[26]

Importantly, <u>the reference never shows or suggests a compensating action in response to such relationships</u>. In fact, *Barnes et al.* seems to indicate the opposite: maintaining a single temperature to arrive at one desired dielectric constant:

> The dielectric constant of the fluoro-organosilicate layer is tunable, in that it can

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[22] Applicants' Specification, Page 9, Lines 16-18.
[23] See the Final Office Action, dated 02/05/04, Page 5, Lines 10-15.
[24] See *Barnes et al.*, Col. 3, Lines 15-25.
[25] See *Barnes et al.*, Col. 3, Lines 15-25 and Col. 4, Lines 12-20.
[26] See *Barnes et al.*, Col. 3, Lines 59-65, which describe mass flow controllers.

> be varied in a range between about 2.5 to about 3.5 as a function of *the* reaction temperature.[27]

That is, Applicants' invention of claim 11 describes varying dopant rate as temperature changes, while *Barnes et al.* teaches on keeping the substrate temperature unchanged.

The only place in which Applicants can find a compensation step appears in Applicants' Specification. Accordingly, the rejection appears to have arrived at Applicants' claim limitations with the benefit of hindsight, and thus is improper.

For all of these reasons, Applicants' believe a prima facie case of obviousness has not been established for claim 11, and this ground for rejection is traversed.

b. Applicants' Arguments Regarding Claim 19 Remain Unrebutted.

Claim 19, which depends from claim 11, is believed to include additional features patentable over the cited references. Claim 19 recites that varying a dopant supply rate includes closed loop control of dopant source supply rate with active temperature feedback from a reaction chamber. Such a limitation is not shown in the cited references.

The rejection has not addressed Applicants' previous showing regarding this claim. Accordingly the argument will be repeated.

Neither *Lin et al.* nor *Wang et al.* provides teachings regarding temperature control of a chamber, thus cannot show or suggest the limitations of claim 19.

Barnes et al. describes forming a fluoro-organosilicate layer in a temperature control chamber. However, the reference never describes controlling a dopant source supply rate with active temperature feedback. The various teachings of the reference will now be discussed in detail to demonstrate this point.

Barnes et al. includes a temperature sensor and feedback loop. However, such features are utilized to maintain a constant temperature and are never utilized to vary the supply rate of any material, let alone a dopant source:

> [T]emperature sensor 172... is also embedded... to monitor the temperature of the pedestal 150 in a conventional manner. The measured temperature is used in a

[27] *Barnes et al.*, Col. 6, Lines 39-42, emphasis added.

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> feedback loop to control the power supply 16 for the heating element 170, such that *the wafer temperature can be maintained or controlled at a desired temperature* which is suitable for the particular process application...[28]

> By properly adjusting the current supplied to the heating element 170, the wafer 190 and the pedestal 150 can be *maintained at a relatively constant temperature* during film deposition. This is accomplished by a feedback control loop, in which the temperature of the pedestal 150 is continuously monitored by a thermocouple 172... This information is transmitted to the control unit 110... which responds by sending the necessary signals to the heater power supply.[29]

From the above it is clear that this portion of the reference teaches feedback to maintain (i.e., not vary) a temperature. Further, the feedback remains unrelated to dopant supply rate and is directed solely to wafer temperature control.

The above is believed to clearly show that *Barnes et al.* uses temperature feedback to maintain a temperature, and not to vary a dopant supply rate.

For these reasons, the combination of reference is not believed to show or suggest all limitations of claim 19. Accordingly, the rejection of this claim is also traversed.

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[28] *Barnes et al.*, Col. 3, Lines 16-23, emphasis added.
[29] *Barnes et al.*, Col. 4, Lines 12-21, emphasis added.

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Claims 11, 14 and 15 have been amended. Claim 13 has been cancelled.

The present claims 1-5, 7-11, and 13-19 are believed to be in allowable form. It is respectfully requested that the application be forwarded for allowance and issue.

Respectfully Submitted,

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Bradley T. Sako
Attorney
Reg. No. 37,923

Bradley T. Sako
WALKER & SAKO, LLP
300 South First Street
Suite 235
San Jose, CA 95113
Tel. 1-408-289-5315